

THE MARS OBSERVER DATABASE; Arden L. Albee, Division of Geological and Planetary Sciences, California Institute of Technology, Pasadena, CA 91125

Mars Observer will study the surface, atmosphere, and climate of Mars in a systematic way over an entire martian year. The observations of the surface will provide a database that will be invaluable to the planning of a future Mars sample return mission.

Mars Observer is planned for a September 1992 launch from the Space Shuttle, using an upper-stage. After the one year transit the spacecraft is injected into orbit about Mars and the orbit adjusted to a near-circular, sun-synchronous low-altitude, polar orbit. During the martian year in this mapping orbit the instruments gather both geoscience data and climatological data by repetitive global mapping.

The scientific objectives of the mission are:

- Determine the global elemental and mineralogical character of the surface material;
- Define globally the topography and gravitational field;
- Establish the nature of the magnetic field;
- Determine the time and space distribution, abundance, sources, and sinks of volatile material and dust over a seasonal cycle;
- Explore the structure and aspects of the circulation of the atmosphere.

The science investigations and instruments for Mars Observer have been chosen with these objectives in mind. These instruments, the principal investigator or team leader and the objectives of the investigation are as follows:

Gamma Ray Spectrometer (W. Boynton)

1. Determine the elemental composition of the surface of Mars with a spatial resolution of a few hundred kilometers through measurements of incident gamma-rays and albedo neutrons (H, O, Mg, Al, Si, S, Cl, K, Fe, Th, U).
2. Determine hydrogen depth dependence in the top tens of centimeters.
3. Determine the atmospheric column density.
4. Determine the arrival time and spectra of gamma-ray bursts.

Mars Observer Camera (M. Malin)

1. Obtain global synoptic views of the martian atmosphere and surface to study meteorological, climatological, and related surface changes.
2. Monitor surface and atmosphere features at moderate resolution for changes on time scales of hours, days, weeks, months and years.
3. Systematically examine local areas at extremely high spatial resolution in order to quantify surface/atmosphere interactions and geological processes.

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Visual and Infrared Mapping Spectrometer (L. Soderblom)

1. Produce km-resolution mosaics of the martian surface in 320 spectral channels for the purpose of identifying mineralogical and chemical units, studying the distribution of surface volatiles and understanding the physical structure of the regolith.
2. Produce a regional map of the martian surface at 10 km resolution in 10 wavelengths.

Thermal Emission Spectrometer (P. Christensen)

1. Determine and map the composition of surface minerals, rocks and ice.
2. Study the composition, particle size, and spatial and temporal distribution of atmospheric dust.
3. Locate water-ice and carbon dioxide condensate clouds and determine their temperature, height and condensate abundance.
4. Study the growth, retreat and total energy balance of the polar cap deposits.
5. Measure the thermophysical properties of the martian surface (thermal inertia, albedo) used to derive surface particle size and rock abundance.
6. Determine atmospheric temperature, pressure, water vapor, and ozone profiles, and seasonal pressure variations.

Pressure Modulator Infrared Radiometer (D. McCleese)

1. Map the three-dimensional and time-varying thermal structure of the atmosphere from the surface to 80 km altitude.
2. Map the atmospheric dust loading and its global, vertical and temporal variation.
3. Map the seasonal and spatial variation of the vertical distribution of atmospheric water vapor to an altitude of at least 35 km.
4. Distinguish between atmospheric condensates and map their spatial and temporal variation.
5. Map the seasonal and spatial variability of atmospheric pressure.
6. Monitor the polar radiation balance.

Radar Altimeter and Radiometer (D. Smith)

1. Provide topographic height measurements with a vertical resolution better than 0.5% of the elevation change within the footprint.
2. Provide RMS slope information over the footprint.
3. Provide surface brightness temperatures at 13.6 GHz with a precision of better than 2.5K.
4. Provide well sampled radar return wave forms for precise range corrections and the characterization of surface properties.

Radio Science (G.L. Tyler)

Atmosphere

1. Determine profiles of refractive index, number density, temperature, and pressure at the natural experimental resolution (approx. 200m) for the lowest few scale heights at high latitudes in both hemispheres on a daily basis.
2. Monitor both short term and seasonal variation in atmospheric stratification.
3. Characterize the thermal response of the atmosphere to dust loading.
4. Explore the thermal structure of the boundary layer at high vertical resolution (approx. 10m).
5. Determine the height and peak plasma density of the daytime ionosphere.
6. Characterize the small scale structure of the atmosphere and ionosphere.

Gravity

1. Develop a global, high-resolution model for the gravitational field.
2. Determine both local and broad scale density structure and stress state of the martian crust and upper mantle.
3. Detect and measure temporal changes in low degree harmonics of the gravitational field.

Magnetometer (M.Acuna)

1. Establish the nature of the magnetic field of Mars.
2. Develop models for its representation, which take into account the internal sources of magnetism and the effects of the interaction with the solar wind.
3. Map the martian crustal remanent field using the fluxgate sensors and extend these in-situ measurements with the remote capability of the electron-reflectometer sensor.
4. Characterize the solar wind/Mars plasma interaction.
5. Remotely sense the martian ionosphere.

The Mars Observer project will utilize data standards and all mission data will be stored in a project database. Investigators and analysts will access the database to participate in the planning process and to provide status and higher-order data products. This process will facilitate the use of the Mars Observer database by the planetary science community.

THE SAMPLE SITE ON MARS/ Arden L. Albee, Division of Geological and Planetary Sciences, California Institute of Technology, Pasadena, CA 91125

The first two days of this workshop are to be devoted to a summary of our knowledge of Mars-- its formation; the evolution of its interior and tectonics; the impact, aeolian, volcanic, fluvial, and volatile-related processes on its surface; the atmosphere, weather, and climate; and the likelihood of life, now, or in the past. These presentations lead naturally into a consideration of the questions that remain to be answered and to a discussion of the numerous sample types and sampling sites required to answer the wide variety of questions. This part of the workshop is very important, but it is even more important to discuss in great detail how to choose a single sample site on Mars.

It is quite possible that only a single Mars sample return, hopefully with a backup, will be initiated. Even if a series of missions should be approved initially, the study of the first Mars sample must provide a significant scientific advance toward our understanding of Mars and the inner planets. Thus, it is tempting to choose a complex site where a variety of questions can be addressed by samples collected by a 100 km rover traverse. However, it can be argued that the prime sampling objective of a first mission should be to collect both fresh and weathered samples of the most abundant types of materials in the near vicinity of the lander.

Numerous candidate landing sites have been studied in the high-resolution Viking images. Some sites are totally underlain by a single bedrock unit, while others contain several units in close proximity. Missions with a prime objective of sampling several units are more demanding in terms of landing location error, mobility, and sampling capability. Of course any site on Mars will contain a variety of wind-blown and impact-derived debris, which will increase the probability of sample variety. Samples of atmosphere gases and soil volatiles can also be collected at any site and will provide information about atmospheric/surface interactions and on the extent of planetary degassing and retention.

On the Viking images it is possible to identify relatively-young volcanic rocks that underlie areas of size similar to the landing error ellipse. Study of the orbital images of some such areas indicates that a mobility of several kilometers should be sufficient to travel from any random point in a given landing ellipse to the nearest outcrop or young crater that might provide unweathered material. From geochemical, petrological and age-dating studies of such volcanic rocks, we expect to be able to decipher the thermal history of the martian mantle, the extent of its chemical differentiation, and the process involved in near-surface chemical fractionation. We can expect to establish more narrow limits on the bulk composition of the planet; to determine the fundamental properties of that region of the solar nebula from which Mars accreted; to determine the ages of lavas erupted onto the surface (which will in turn provide ground truth for ages based on the cratering statistics, allowing us to extend these ages to the rest of Mars and by inference to the inner planets); and to establish the nature of martian volcanic gases and the extent to which these gases have contributed to building up the martian atmosphere.

Based on such considerations, I suggest that the first sampling mission to Mars should be targeted to a landing site within a large (> 50km diameter), relatively-young (by crater counts), volcanic unit, one that can be mapped into the regional geologic picture (based on the highest resolution Viking images). Collection from adjacent units should not be a prime objective in designing the mission. In addition the site should be at low altitude, near-equatorial and "hazard-free". At this workshop it is important that we focus on the need to study and compare those few sites that do meet such criteria.

References:

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